R645-301-600 GEOLOGY SECTION

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Doelling, H.H., 1972, Wasatch Plateau Coal Fields, *in* Doelling, H.H. (ed.), Central Utah Coal Fields; Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery, Utah Geological and Mineralogical Survey Monograph Series No. 3, Salt Lake City, Utah.

R645-301-600 GEOLOGY SECTION

R645-301-610. INTRODUCTION

This part of the application provides a detailed description of the geology of the coal resources, surrounding strata, and surface features within the Mill Fork permit area (State Lease ML-48258/UTU-84285) and surrounding areas.

Since 1971, detailed data on the geology of the coal deposits within the permit and surrounding area have been collected, compiled, and analyzed by PacifiCorp and several government agencies. Information collected by PacifiCorp is the result of exploratory drilling, field investigations, geologic mapping, field sampling, aerial photography, and mapping of underground mine workings.

PacifiCorp has also used numerous geologic reference works by previous authors and agencies specifically written about the coal deposits of this area for the preparation of this section.

R645-301-611. GENERAL REQUIREMENTS

The geology within and adjacent to the Mill Fork permit area is discussed in Sections R645-301-621 through R645-301-627.

R645-301-611.200. Proposed operations as given under R645-301-630

Proposed mining operations are discussed in section R645-301-630, including mine layout and sequencing.

645-301-612. CERTIFICATION

All maps and drawings within R645-301-600 have been certified by a registered professional engineer.

645-301-620. ENVIRONMENTAL DESCRIPTIONS

The Mill Fork permit area, ~~called the Mill Fork Lease (ML-48258)~~, consists of the Mill Fork State Lease, approximately 5,563 acres and adjacent Federal Coal Lease UTU-84285, approximately 213.57 acres of coal lands located in the Wasatch Plateau coal field of central Utah (See Figure 1, Introduction). The Mill Fork permit area is located entirely within Emery County.

The Wasatch Plateau is one of several high plateaus in central Utah located along the western boundary of the Colorado Plateau geological province. The geology of this region is characterized by flat-lying sedimentary rocks, ranging in age from Paleozoic to Recent, with simple geologic structures such as gentle folds and mostly normal faulting. This thick "layer-cake" of sedimentary rocks has been deeply dissected by erosion. The Mill Fork permit area~~Lease~~ consists of the surface and subsurface coal resources that underlie the north end of East Mountain, one of several high, flat north-south ridges that make up the Wasatch Plateau. The headwaters of Mill Fork Canyon and Crandall Canyon cut into East Mountain on the eastern side of the lease. The steep escarpment of the Joes Valley fault forms the western boundary of the lease. Elevations range from 7,500 feet in the lowest areas to over 10,000 feet at the tops of the plateaus, resulting in a broad diversity of climatic conditions and flora and fauna over the permit area. Annual rainfall in the region ranges from about 10 inches per year in the lower canyon bottoms to over 30 inches per year in high elevation areas. The dry climate of this area promotes erosion by inhibiting plant growth at lower elevations and on south-facing slopes.

A. REGIONAL GEOLOGY

The Energy West Mining Company mines and permit areas are located in the central portion of the Wasatch Plateau Coal Field in Emery County, Utah. Generally, this area is a series of high, flat-topped mesas flanked by heavily vegetated slopes which extend downward to precipitous cliffs. Below these cliffs steep slopes gradually flatten out into a broad flat valley (Castle Valley) below. Topographic relief of up to 5,000 feet can be measured from the top of the plateau to Castle Valley below. Horizontal coal seams occur within the strata of the Wasatch Plateau, about halfway between the valley floor and the top. The following discussion summarizes the stratigraphy and structural geology of the region and within the Energy West Mining Company permit area.

Figure GF-1
Stratigraphy of East Mountain
(After Doelling, 1972)

Period	Epoch/Age	Stratigraphic Unit		Thickness, feet	Description
QUAT.	Holocene (Recent)		Alluvium	0 - 200'	Valley fills, poorly sorted clay to boulders
TERTIARY	Paleocene	Wasatch Group	Flagstaff Limestone	100 - 200	Fossiliferous lacustrine limestone, gray
	Maastrichtian		North Horn Formation	500 - 1500	Variegated mudstones and clays, occasional sandstones & limestones, forms hummocky terrain.
CRETACEOUS		Mesaverde Group	Upper Price River Formation	600 - 800	Coarse-grained sandstones, occasional conglomerates, interbedded mudstones
	Campanian		Castlegate Sandstone (lower Price River Formation)	200 - 400	Coarse grained sandstone, occasional conglomerate lenses, tan color, massive cliff-former
			Blackhawk Formation	600 - 800	Interbedded mudstones, siltstones, and sandstones, bottom 150 feet contains coal seams and rider seams.
			Star Point Sandstone: Spring Canyon tongue Storrs tongue Panther tongue	200 - 400	Sandstone, gray-white, 3 main units inter-tongue with underlying Masuk Shale, tops of units occasionally bleached white, indicating overlying coal seams.
	Santonian	Mancos Shale	Masuk Shale Member	1,000 - 1,300	Shale, gray, soft, slope former
			Emery Sandstone	50 - 800	Sandstone, yellow-gray, cliff-former. May be associated with coal seams. Subsurface only in Mill Fork Lease.
	Coniacian		Blue Gate Shale Member	1,500 - 2,400	Shale, blue-gray, nodular, irregularly bedded, forms badlands. Subsurface only in Mill Fork Lease.
	Turonian		Ferrron Sandstone Member	50 - 950	Sandstone, yellow-gray, intertongues with Mancos shale, associated with important coal beds of Emery coal field, source of coal bed methane.

The regional geology of the Colorado Plateau in which the Wasatch Plateau coal field is situated is fairly simple. Sedimentary rocks have been accumulating in this region since Permian time (see Figure GF-1). A broad, high, flat region that encompasses southeastern Utah, southwestern Colorado, northwestern New Mexico, and northern Arizona, the Colorado Plateau has been an area of relative stability while mountain-building episodes have occurred in surrounding regions. The thick accumulations of sedimentary rocks in this region are being deeply dissected by erosion, leaving the most recent coal reserves in the higher plateaus, where they are now being mined. The Energy West permit area covers portions of East Mountain and Trail Mountain, which are separated by Cottonwood Canyon, a deep, partially glaciated valley.

During late Cretaceous (Campanian) time, from 75 – 85 million years ago, the Wasatch Plateau region lay at the edge of the Western Interior Cretaceous Seaway, with the sea to the southeast and a range of mountains (the Sevier Orogeny) to the northwest. Streams from these mountains brought eroded sediments southeast to the sea. Stagnant areas between these stream and river channels contained swamps in which peat accumulated. These stream channel and coal swamp deposits are now called the Blackhawk formation, a member of the Mesaverde Group of Cretaceous formations. During Campanian time, the sea advanced and receded several times, leading to the formation of several stacked coal seams within the Blackhawk sediments. The coal seams present in the Energy West permit area are named from lowest (oldest) to highest (youngest) the Hiawatha, Cottonwood, and Blind Canyon Seams. The Hiawatha and Blind Canyon seams are separated by 30 – 100 feet of interburden.

B. REGIONAL GEOLOGY SEDIMENTARY FORMATIONS

Numerous sedimentary rock formations are exposed in the Wasatch Plateau both above and below the coal bearing Blackhawk formation. Mining and construction activities affect a number of these, and the composition, arrangement, and physical characteristics of these formations greatly affect the mining and hydrologic characteristics of the area.

The geologic formations exposed in the Energy West permit area range from Upper Cretaceous (100 million years old) to Tertiary and Recent in age (see Figures MFU-1823D and GF-1). These formations, in ascending order from oldest to youngest, are the Masuk Shale member of the Mancos Shale, the Star Point Sandstone, the Blackhawk Formation, the Castlegate Sandstone, the Upper Price River Formation (all Cretaceous), and the North Horn Formation, and the Flagstaff Limestone (Tertiary). The coal deposits are restricted to the lower portion of the Blackhawk Formation, about 2,500 feet below the top of the Plateau. Recent geologic deposits include numerous stream terrace gravels along streams and rivers, glacial till deposits in the upper reaches of Cottonwood Canyon, and alluvial and colluvial fills in all of the significant drainages.

The Masuk Shale is the upper-most marine member of the Mancos Shale and consists of light to medium gray marine mudstones. This formation weathers readily, forming gray slopes that are often covered by debris and little or no vegetative cover. The Masuk shale is several hundred feet in thickness, and is the lowest and oldest of the geologic units exposed in the permit area. This formation is generally devoid of groundwater.

Overlying and intertonguing with the Masuk Shale is the Star Point Sandstone, a beach-front sandstone. In the East Mountain area the Star Point Sandstone ususally consists of three prominent massive cliff-forming beach-front sandstones totaling about 400 feet in thickness. These sandstone “tongues” are named from bottom to top: the Panther, the Storrs, and the Spring Canyon. In between the three tongues are beds of the Masuk Shale. The intertonguing of the Star Point and Masuk shale represents three transgression / regression episodes along the shoreline of the Cretaceous Interior seaway. The upper contact of the Star Point Sandstone is usually abrupt and readily identifiable on outcrops. Even though the Star Point Sandstone underlies almost the entire permit area, the low permeability and lack of recharge limit its usefulness as a water producing aquifer. The Star Point Sandstone occasionally exhibits aquifer characteristics in localized areas. These are isolated occurrences where regional faults have created secondary permeability and have been intersected by major canyons with perennial streams. An example of this type of occurrence is Little Bear spring located in Huntington Canyon.

The Blackhawk Formation consists of alternating mudstones, siltstones, sandstones, and coal. Although coal beds are generally found throughout the Blackhawk Formation, the thickest economically mineable seams are restricted to the lower 150 feet of the formation. The sandstones contained within the Blackhawk Formation are mostly fluvial stream channel deposits and increase in number in the upper portions of the formation. Fluvial sandstone channels that are in contact with the top of the coal seams occasionally cut into the coal (due to the erosion of peat by stream erosion during deposition) and create thinned coal zones called “scours.” Many of the tabular sandstones and sandstone channels contain perched water, mostly in fractures, joints, and bedding planes. The permeability of these sandstones is relatively low. Mudstones surrounding these channels usually function as aquicludes. The total thickness of the Blackhawk Formation in the East Mountain area is about 750 feet. The Blackhawk Formation usually forms a broad, consistent slope between the Star Point Sandstone cliffs below and the Castlegate Sandstone cliffs above.

The Castlegate Sandstone is the lower member of the Price River Formation. The Castlegate Sandstone sits on top of the Blackhawk Formation and forms a prominent 300-foot cliff in highly eroded areas of the southern outcrops of the permit area (the southern end of the Cottonwood and Trail Mountain mines), steep blocky slopes in moderately eroded areas (Rilda Canyon), and occasional blocky outcrops in forested or heavily vegetated areas (Mill Fork Canyon). The Castlegate Sandstone consists of about 200 to 400 feet of coarse-grained, arkosic, light tan fluvial sandstones; pebble conglomerates; and minor layers of mudstone.

The Upper Price River Formation, which overlies the Castlegate Sandstone, is about 600 to 800 feet thick and forms slopes which extend upward from the Castlegate Sandstone escarpment. The Upper Price River Formation is comprised predominantly of fine to coarse- grained sandstone but commonly contains mudstone beds between the point bar deposits. Although some mudstones are present, fine-grained, poorly sorted (occasionally conglomeratic) sandstones dominate the Upper Price River Formation.

The North Horn Formation is about 500 to 1000 feet thick in the East Mountain area. The North Horn Formation spans the Cretaceous-Tertiary boundary (65 million years ago). Mudstones and claystones dominate the rock types present and are generally gray to light brown in color, although black, pink, purple and greenish colors have been seen. The lower two thirds (upper Cretaceous in age) of the formation is generally highly bentonitic mudstone. Localized, lenticular sandstone channels are present throughout the formation. The sandstone beds are more common near the upper and lower contacts of the formation. The North Horn formation, because of the soft rock types present, is prone to slumping. Widespread areas of slumping and hummocky terrain are present in North Horn outcrops.

The Flagstaff Limestone is the youngest (Paleocene) and highest formation exposed in the permit area and consists of dense, white to light gray lacustrine limestone with abundant fossil shells. Resistant to erosion, remnants of 100 to 150 feet of this formation remain, forming caps on the highest plateaus.

Between the time of sediment accumulation and erosion, the sedimentary rocks of the Wasatch plateau were intruded by widely scattered igneous dikes. The approximate age of these dikes ranges from 8 to 24 million years. Though more common in the northern parts of the Wasatch Plateau, several dikes are known to exist within the Genwal Mine, just to the north of the northern permit boundary. These dikes are only a few feet or inches wide, and are traceable for only a few hundred feet. The extent and continuity of these dikes at depth is unknown, and the effects on mining, if any, are unknown at this time.

Stream terrace gravels have been deposited along the major rivers and valley floors at various historic erosional levels, and lay unconformably on top of the Masuk shale. These terrace gravels are extensively used locally for construction gravels. Some are partially cemented together by caliche – type calcareous cement. None of these terrace gravels occur at or above the coal mining levels. None of these gravels contain groundwater.

Glacial-till deposits are present in the upper half of Cottonwood Canyon. The classic ‘U”- shaped valley and presence of a terminal moraine show that this valley contained a small glacier during the last Pleistocene ice age (10,000 to 12,000 years ago). The depth of this till ranges from 80 to 150 feet thick at the valley floor. The groundwater characteristics of this till and the groundwater hydrology of Cottonwood Canyon are being closely monitored by Energy West Mining Company.

Most of the main drainages and side canyons in the permit area contain alluvial fill as a valley floor material. The depth of this fill material can be up to 100 feet in some of the major stream valleys. Seasonal streams, ground water, and various springs are present in these alluvial fills. The groundwater and surface water hydrology of these alluvial materials are closely studied and monitored by Energy West Mining Company.

C. STRUCTURAL FEATURES:

Several important structural features, the Straight Canyon Syncline, Flat Canyon Anticline and Huntington Anticline, the Roans Canyon Fault Graben, Mill Fork Fault Graben, Left Fork Fault Graben, Pleasant Valley Fault, and the Deer Creek Fault, have been identified adjacent to and within the Mill Fork permit area (see Map MFU-1823D, Geologic Formations Map).

Folding:

Strata in the Mill Fork area are gently folded in two broad structural features. The Flat Canyon Anticline crosses the southeastern portion of the permit area. This anticline trends southwest to northeast, and plunges to the southwest. Dips in the anticline range from two to six degrees with the south limb dipping the steepest.

To the north, the north limb of the Flat Canyon Anticline becomes the south limb of the Crandall Canyon Syncline, a flat-bottomed syncline. This syncline also trends southwest to northeast. Dips on the northwest side are much steeper than on the southeast side.

Faulting:

The only known fault within the Mill Fork permit area is the Joes Valley Fault, which forms the western limit of the coal reserves in this permit area. The Joes Valley Fault is the largest and most prominent of several north south trending fault zones within the

Wasatch Plateau coal field. Displacement of the fault is approximately 1,500 feet, downthrown on the western side. The fault creates a continuous north-south escarpment on the east side of Joes Valley. Several side canyons are cut into this escarpment on the western side of the permit area, all of which drain into Joes Valley. The fault zone itself is not visible along this escarpment, but the fault has been intercepted underground in the Genwal mine to the north. Where the fault has been intercepted in the Genwal mine workings, a drag fold is present, indicated by a gentle downward folding of the strata along the fault zone, extending for a few hundred feet to the east of the fault. The following section describes the depiction of the Joes Valley Fault in various publication through time.

Chronology of the Depiction of the Joes Valley Fault in Various Publications

Introduction:

The Joes Valley Fault forms the eastern boundary of the Joes Valley Graben, a fault – formed valley that stretches from the vicinity of Scofield, Utah on the northern end , to Interstate 70 in the south near Fremont Junction, a distance of about 50 miles. It is a highly visible and well-known geologic feature, immediately recognizable on geologic maps and in aerial and space photography. It is a normal fault, with a displacement of about 1,500 feet, downthrown to the west.

The Joes Valley Fault is significant to Energy West because it forms the western physical boundary of two of Energy West's mining areas, the Mill Fork, and the Trail Mountain mining area. It also formed the western boundary of the adjacent Genwal Mine property to the north. The western boundary of the Mill Fork State Lease and Genwal western leases were configured roughly along the surface trace of the fault before the tract was leased.

For the purposes of leasing and mining, it is important to know where this fault is located both on the surface and at the level of the coal seams that are being mined (coal seam depth in the fault intercept area ranges from about 700 feet up to 1,200 feet). Mining near the fault zone could potentially have impacts on surface subsidence and hydrology. Mining near or at the fault at depth could have detrimental effects on mining (water inflows, bad ground conditions) and on mine planning. As this is a normal fault, a steep dip to the west is expected, with a fault intercept at depth some distance to the west of the surface trace.

As Energy West's Deer Creek Mine workings approached the fault from the east in late 2005, it became an important issue to locate the fault as closely as possible both on the surface (Section 15, T. 16 S, R. 6 E.) and underground so that Energy West could apply for an extension or addition (Lease By Application) to ML-48258 to optimize reserve recovery in the area of the fault. The location of the surface trace of the fault became an important issue in the LBA process.

Mapping History:

Refer to the Joes Valley Fault locations in figure GF-2, which shows the various interpretations of the fault location over time for Section 15, T. 16 S, R. 6 E. The original surface fault trace used in Energy West's maps was taken from a map in Doellings (1972) report on the coal reserves of the Wasatch Plateau. In Doellings report, the fault is shown on two maps – a reproduced map from a 1955 edition of the A.A.P.G. Bulletin #39, showing the fault on a non-topographic structure map and a 15-minute USGS topographic map (publication date 1923), with the surface fault trace drawn on based on topography. Both of these maps show the fault trending from south-southwest to north-northeast, along the base of East Mountain.

In 1996, the Joes Valley Fault was encountered underground in the west mains development of the Genwal Mine. Ground conditions at the fault zone were relatively good, with little sympathetic faulting or fracturing, and only damp conditions at the fault intercept. Genwal Mine went on to develop bleeder entries, setup faces, and longwall panels in close proximity to the fault zone for several years (1997 – 2002) after the initial intercept. Genwal mined adjacent to the fault trace for approximately 1.5 miles, mapping in the process the trend of the fault zone and its relationship to the surface trace. Additional sympathetic faults to the east of the main fault zone caused problems for Genwal's northernmost developments. To this date, no known subsidence or fault-related ground movements have occurred above Genwal's extensive mining near the fault.

In 1997, as the Mill Fork State Lease was being prepared for the leasing process, another map depicting the surface trace of the fault was prepared by the USDA Forest Service for the Environmental Analysis for Lease by Application #11 (Mill Fork Lease Tract). This map shows the surface fault trace angling due north in Section 15, a slightly different interpretation than in the existing literature.

In 2001, as Energy West was preparing permitting documents for the Mill Fork State Lease, a map of all known geologic features in the Mill Fork area was constructed for inclusion in the permit application (Geologic Formations Map MFU-1823D). The Joes Valley fault on this map was based on Doelling's interpretation of the fault location, interpretation of recent aerial photographs of the area, and on surface elevation contours that were generated by digitizing a USGS 7.5 minute quadrangle map (publication date

1979). The contours of the 7.5 minute map are more modern and more accurate than those of Doelling's 15-minute contour map.

In 2005, Energy West obtained an integrated set of surface mapping products for the Mill Fork Lease area that consisted of 20-foot surface elevation contours generated by stereo aerial imagery, and a set of ortho-photo images also generated by the stereo aerial photographs, but spliced together and adjusted to exactly match the surface contours and surveyed surface control points. This data set allows aerial photographic interpretations of objects on the surface to be transferred directly and accurately on to contour maps. Using these tools, the surface fault trace was mapped directly from the ortho-photo images, on which the fault trace is clearly visible, directly to Energy West's mine and surface maps. The fault trace on this map is in a slightly different location than on previous maps, being slightly to the west from the previous interpretation of 2001.

While the Joes Valley Fault trace is clearly visible on aerial photographs and from the air, the fault plane itself is not visible in Joes Valley, refer to figure GF-3. It is either obscured by recent sediments, or vegetation, or both. As a result, the fault itself cannot be located, surveyed or measured directly on the ground surface. Tools that Energy West has used to better locate the surface fault trace have been topography and topographic expressions of the fault trace, aerial photography, aerial reconnaissance, and ground resistivity and induced polarization surveys across the fault trace.

Energy West Mining Activities:

In late 2005 and 2006, underground mining in the Mill Fork State Lease reached the area of the Joes Valley fault in Section 15. 14th West continuous miner section reached a stopping point (based on the Mill Fork State Lease boundary, not the fault) in November,

2005. From this point at crosscut #70, a horizontal core hole was drilled due west toward the fault. Based on the surface trace of the fault then in use on Energy West's map (the 2001 interpretation), the fault should have been encountered at about 500 feet, if the fault plane was vertical. The hole was drilled to about 490 feet before mine logistics issues forced the removal of the drill from the area. No evidence of faulting or fault-related fracturing was observed in the core samples. This hole did show that the fault at depth was at least as far west as was shown on the map at that point in time, and that the dip of the fault was probably inclined to the west, making the underground intercept farther west than the surface intercept.

In April, 2006, the 15th West continuous miner section also reached the projected vicinity of the Joes Valley Fault. By this time, the new 2005 interpretation of the Joes Valley Fault surface trace was in use by Energy West. Using horizontal directional rotary drilling, the fault was located in two places to the northwest of the advancing faces. The fault was identified by rock intercepts in the horizontal holes, and by fault-related materials (sand and water) flowing from the fault zone. These fault intercepts placed the fault plane at depth about 110 feet west of the new surface trace interpretation. The 15th West Section of the mine was advanced to within 140 feet of the fault without seeing any traces of faults or related fractures, refer to figures GF-3 and GF-4. From 15th West, 14th West section (which had stopped about 650 feet short of the new subsurface projection of the fault) was extended 450 feet closer to the fault.

The nearest known faulting outside of the permit area is the Mill Fork fault graben. The Mill Fork fault graben passes to the southeast of the permit area (see Map MFU-1823D, Geologic Formations Map). This fault graben was crossed in ARCO's Huntington Canyon #4 Mine in Mill Fork Canyon and has a displacement of about twenty five (25) feet on the each side. The trend of this fault zone is approximately N 40º E. Based on projections from maps of #4 Mine, this graben should pass by the southeast corner of the permit area, between the Mill Fork State Lease and the existing Deer Creek Mine. Where it crosses the northern end of East Mountain, the fault has been mapped to have a displacement of thirty (30) feet down on the northwest side. Deer Creek mine workings have not intercepted this fault zone and exploration drilling in the right fork of Rilda canyon does not show any displacement, indicating that the displacement of the fault zone is too small to measure with exploration drilling, or that it has disappeared in this area. This fault zone does not appear in any surface outcrops.

R645-301-622 CROSS-SECTIONS, MAPS, AND PLANS

Map MFU-1823D, the Geologic Formations Map shows the locations and elevations on the surface of all exploration drillholes and test wells within the permit area. Thirty-five (35) coal exploration holes and one gas well have been drilled within the permit area to date (August 2005). In 1975 Utah Geologic and Mineral Survey (UGMS) drilled DH-2. Five (5) holes were drilled by the USGS in the early 1980s: CLB-1, CLB-2, CLB-3A, SLB-1, and SLB-3. Two (2) holes were drilled by ARCO Coal Company in 1981: HC-2 and HC-3. PacifiCorp has drilled twenty-seven (27) holes to date within the lease (EM-169 through EM-195). The single gas well on the property, Federal 32-23, was drilled in 1987, by Meridian Oil and Gas Co.

R645-301-621.200. Nature, Depth, and Thickness of the Coal Seams to Be Mined

Mining operations at PacifiCorp's mines have historically mined the two major seams present in the area, the Blind Canyon (upper) and the Hiawatha (lower) seams. The coal-bearing portion of the Blackhawk formation is the lower half of the formation, with the Hiawatha seam at or just above the interface between the Blackhawk formation and the Star Point Sandstone below.

Both the Hiawatha and Blind Canyon coals are ranked as High-Volatile Bituminous 'B' low sulfur coals.

The coal reserves in the Mill Fork permit area~~Lease~~ and remaining reserves at Deer Creek are in both the Hiawatha and Blind Canyon seams. The Hiawatha and Blind Canyon seams are close together, usually within 80 vertical feet. The depths of both seams, therefore, are similar in those areas where both seams are present. Overburden depths (Maps MFS 1824D & MFS 1825D) range from 0 feet, where both seams outcrop at the surface, up to about 2,600 feet under the Flagstaff Limestone "caps" on East and Trail mountains. The overburden strata consist of those formations already listed in section R645-301-621:

- Flagstaff Limestone
- North Horn Formation
- Upper Price River Formation
- Castlegate Sandstone
- Blackhawk Formation

Localized rider coal seams are fairly common above both seams, occurring from 1 foot to 20 feet or more above the Hiawatha and Blind Canyon seams. None of these rider seams have been named or mined.

In this region of the Wasatch Plateau, the Hiawatha seam is the lowest coal seam present. In much of the mining area currently permitted by PacifiCorp, the Hiawatha seam rests directly on the Star Point Sandstone, a massive, medium-grained, brownish-gray sandstone, which makes a very good mine floor. In some areas, there are between 0 and 15 feet of interbedded softer mudstones and siltstones between the Hiawatha and the Star Point Sandstone.

Thickness of the coal seams is variable, ranging from as little as 0 feet up to 19 feet in the Blind Canyon and from 0 feet up to 19 feet in the Hiawatha. Coal thickness is dependent on two main factors – the amount of peat originally deposited in the Cretaceous swamps, which varies from region to region, and the amount of scouring or erosion of the peat that took place after the peat was deposited but before lithification of the sedimentary sequence. More coal was deposited in the center of the swamp areas than around the edges, where distributary stream channels either prevented deposition, or scoured away the peat already deposited.

At some point in time during peat swamp development, the environment of deposition changed and each successive peat swamp was overrun by sediments, mainly mudstones and sandstones. Stream beds that passed directly over the previously deposited peats eroded sinuous channels of various depths into the peat and left behind sand-filled “scours,” which cut varying amounts of top coal from the original thickness. The sudden losses of coal height that occur under these localized scours have impacts on coal mining operations that range from mild to disastrous.

Regional variations in coal thickness in the Blind Canyon and Hiawatha seams have been documented to varying degrees by mining activities and exploration drilling funded by government agencies and industry. Regional thickness trends of these seams are fairly well known, but the localized thickness variations caused by channeling are not as well known due to the localized nature of channeling. The Mill Fork region does not contain many exploratory drillholes because of its remoteness, and only general statements can be made based on this drilling as to the thickness trends in either seam.

R645-301-621.300. All Coal Crop Lines of the Coal to Be Mined

Coal outcrop and projected outcrop lines are shown on Map MFU 1823D. Coal outcrop lines are inferred where the outcrops are concealed by alluvium or colluvium. There are no significant coal outcrops within the Mill Fork permit area ~~lease~~, due to the depth of burial in this area, however, significant outcrops of both seams occur just to the east of the lease boundary in Crandall and Mill Fork canyons.

Strike and dip of the coal seams are shown on Map MFU-1827D and MFU-1828D. The strike of the coal seams varies as the coal beds and surrounding strata are folded by the different structures (Flat Canyon Anticline and Crandall Canyon Syncline) mentioned in the section on structures above. The dip of the coal beds in this area is usually gentle, with dips rarely exceeding 4 or 5 degrees.

R645-301-621.400. Location and Depth of Gas and Oil Wells

Locations of all known oil and gas wells in and around the permit area are shown on Map MFU-1823D. One gas well, Merit Energy Co. East Mountain Unit 32-23, a producing well, is located within the permit boundary in Section 23, T. 16 S., R. 6 E. Total depth of this hole is 7,476', and the hole is completed in the Ferron Sandstone.

R645-301-623 ENVIRONMENTAL GEOLOGIC INFORMATION

R645-301-623.100. Acid- and Toxic-Forming Strata

Extensive sampling and testing of overburden strata, coal , and surrounding rocks has shown that there are almost no materials present that are potentially acid- or toxic- forming media. Almost all samples show slight alkalinity. Yearly sampling of in-mine roof, coal, and floor materials continue to confirm these results. Detailed analyses are presented in Appendix C.

R645-301-623.200 Reclamation Potential

Access to the Mill Fork permit area will be via a set of underground main entries from the existing Deer Creek mine workings. Other than possible future breakout locations for ventilation, there will be no surface facilities or disturbance within the permit boundary. If future breakouts become necessary, they will be permitted in a separate application. Reclamation, if necessary, will be performed in accordance with R645-301 and R645-302.

R645-301-623.300. Subsidence Control Plan

For the purposes of this section and the proposed operations in the Mill Fork area, a subsidence control plan has been developed. Refer to R645-301-500. Engineering for plan details.

Surface subsidence of all of the Energy West permit areas has been carefully surveyed, monitored and documented for almost 20 years. Subsidence is monitored by yearly comparison of new vs. old aerial photography using sophisticated photogrammetric measuring techniques, and is tied to known surveyed control points on the ground. Overflights by helicopter of all mined areas are conducted at least annually to inspect the ground surface. A Subsidence Monitoring Report is published annually, and submitted to various regulatory agencies.

If obvious subsidence - induced cracks appear at the surface, they are reported immediately to the surface-controlling agency and mitigation procedures are implemented if deemed necessary.

R645-301-624 GEOLOGIC INFORMATION

Numerous sedimentary rock formations are exposed in the Mill Fork permit ~~Lease~~ area on East Mountain both above and below the coal bearing Blackhawk formation. The composition, arrangement, and physical characteristics of these formations greatly affect the mining and hydrologic characteristics of the area.

The geologic formations exposed in the Mill Fork ~~Lease~~ permit area range from Upper Cretaceous (100 million years old) to Tertiary and Recent in age (see Figure GF1). These formations, in ascending order from oldest to youngest, are the Masuk Shale member of the Mancos Shale, the Star Point Sandstone, the Blackhawk Formation, the Castlegate Sandstone, the Upper Price River Formation, and the lower part of the North Horn Formation (all Cretaceous), the upper part of the North Horn Formation, and Flagstaff Limestone (Tertiary). Recent geologic deposits include numerous stream terrace gravels along streams and rivers, glacial till deposits in the upper reaches of Cottonwood Canyon, and alluvial and colluvial fills in all of the significant drainages and in Joes Valley.

Vertical relief across the exposures of these formations is about 3,000 feet within the permit area. Overburden thickness above the lowest coal seam to be mined (the Hiawatha seam) ranges from about 200 feet up to about 2,600 feet.

This sedimentary sequence has been structurally modified over time only slightly. Two gentle fold structures, the Flat Canyon anticline and the Crandall canyon syncline, cross the permit area. Dips of the beds are generally very gentle, less than 5 degrees.

Faulting is present within the permit area. On the western side of the permit area, the Joes Valley fault forms the boundary of a major structural graben, called Joes Valley, which cuts off mineable coal reserves to the west. The displacement of this fault is at least 1,500 feet, down thrown on the western side. No other faulting is known to exist within the permit area.

Jointing of the sedimentary formations of the area is a significant and important feature. Jointing of the rocks surrounding the coal seams affects mine orientation and planning, as well as the hydrologic characteristics of the rocks. Joints in the area trend predominantly north – south to N 10º E (parallel to the Joes Valley Fault), with a few secondary sets at other orientations.

Surface and groundwater hydrology has been extensively studied within the permit area and adjacent areas. Surface water originates from melting snow, with a significant runoff season every year. Yearly precipitation has varied widely over the past 20 years, resulting in fluctuations of surface water flows and surface spring discharges.

Alluvial fills in the bottoms of Mill Fork and Crandall canyons have been shown to transport significant quantities of sub-surface water downstream. The streams in the right and left forks of Mill Fork canyon are intermittent, rising out of the alluvium, flowing, and sinking back into the alluvium multiple times as the water moves down-gradient toward Huntington Canyon.

Surface water flowing down the unnamed drainages into Joes valley behaves similarly to the waters moving down Mill Fork Canyon. The small streams in these canyons sink into and re-emerge from the alluvium in the canyon bottoms numerous times. As the streams cross the fault and emerge into Joes Valley, the water disappears into the alluvial fan material that has accumulated at the mouth of each canyon. Farther out in the valley, water emerges from underneath the alluvial fan material, forming a swampy area that parallels the fault trend.

Subsurface water, including water that is intercepted in mine workings, is usually encountered in ancient, perched aquifers. These perched aquifers are usually tabular or stream channel sandstones, which have moderate porosity, but low permeability. Water also is encountered perched in the open joint systems within these rocks. Subsurface water has also been encountered in some isolated incidents in fault zones and structural synclines, notably the Roans Canyon fault zone and Straight Canyon syncline, about 5 miles south of the permit area.

Extensive research has shown that the surface and underground hydrologic systems are not hydraulically connected. No impact to surface hydrologic systems is anticipated within the permit area. Some perched water will be encountered underground during mining activities within the permit area. The location and quantity of water encountered underground will depend on the types of rocks, joint patterns and geologic structures that are present.

R645-301-624.200. Overburden Removal

Since all mining and access related to the Mill Fork ~~permit~~ area will be underground, no portion of the permit area will be exposed to or adversely impacted by mining. Analyses of overburden materials are presented in Appendix C and in Table G-1 of the Deer Creek / Cottonwood / Des-Bee-Dove Geologic Section, Volume 8.

R645-301-624.230. Chemical Analyses of the Coal Seam for Acid- and Toxic- Forming Materials

Chemical analyses for the Blind Canyon and Hiawatha coal seams within the permit area are available from drill cores from Energy West drill holes EM-169 through EM-179, EM-182, EM-184 and EM-185, and ARCO drill holes HC-2 and HC-3. Coal core samples taken from Mill Fork Lease drill holes are tabulated in R645-300- Appendix A.

Sulfur forms data for the Blind Canyon and Hiawatha coal seams within the permit area are available from drill cores from ARCO drill holes HC-2 and HC-3. These results are tabulated below:

SULFUR FORMS		
	Blind Canyon Seam	Hiawatha Seam
Pyritic	0.03	0.09
Sulfate	0.00	0.00
Organic	0.47	0.43
Total	**0.50**	**0.52**

R645-301-624.310. Drill Hole Logs

R645-300 Appendix B contains a tabulation of all drill hole logs within the permit area. Drillhole DH-2 (UGMS, 1975) is reproduced as a typical drill log in this appendix. All drill hole logs are available for review at Energy West Mining's main office in Huntington, including the proprietary holes completed by PacifiCorp.

R645-301-624.320. Chemical Analyses for Acid- or Toxic- Forming Materials

R645-300 Appendix C contains a table of analyses for acid- and toxic- forming or alkalinity-producing materials above and below the coal seams to be mined.

R645-301-624.330. Pyritic and Total Sulfur Chemical Analyses

A table of sulfur forms analyses for the Blind Canyon and Hiawatha seams is presented in the R645-301-624-230.

R645-301-627 DESCRIPTION OF OVERBURDEN

Overburden above the lowest seam to be mined (the Hiawatha Seam) is shown on Map MFU-1829D, Geologic Cross-Sections and Figure GF-1. The overburden above the coal seams to be mined includes the Blackhawk formation, the Castlegate Sandstone, the Upper Price River formation, the North Horn formation and the Flagstaff Limestone.

The Blackhawk formation consists of interbedded fluvial mudstones, siltstones, sandstones and coals. The vertical makeup of this formation is highly variable. Generally, the Blackhawk is sandier toward the top, and shalier toward the bottom. The mineable coal seams are usually within the bottom 300 feet of the formation, along with numerous rider seams and carbonaceous mudstones. This formation usually forms a long, steep slope (about 40 degrees) with frequent outcrops of large channel sandstones. The Blackhawk formation ranges from 600 to 800 feet thick in the permit area.

The Castlegate Sandstone, which comprises the lower half of the Price River formation, is a prominent cliff-forming sandstone, which forms cliffs or steep blocky outcrops which are visible nearly everywhere in the permit area. The Castlegate is a massive, coarse grained, occasionally conglomeratic or arkosic sandstone. The prominent North – South joint set is usually clearly visible in outcrops of the Castlegate. The Castlegate Sandstone averages about 300 feet thick in the permit area.

The Upper Price River formation consists of interbedded coarse-grained sandstones that resemble those of the Castlegate Sandstone, but are softer, and interbedded with occasional mudstones. The Upper Price River formation forms a steep slope above the Castlegate Sandstone cliffs. The thickness of the Upper Price River formation is difficult to determine, due to its gradational contact with the overlying North Horn formation, but is probably about 600 feet thick in the Mill Fork permit area.

The contact between the Upper Price River formation and the North Horn formation is difficult to discern on East Mountain, but is generally picked as the change in slope from the steeper outcrops of the Upper Price River formation below to the gentler and more rolling slopes of the North Horn formation above.

The North Horn formation is a softer formation which forms the rolling, slumping, hummocky terrain near the top of East Mountain. The North Horn consists mostly of interbedded shales and clays, with occasional sandstone and fresh water limestone beds. The North Horn formation has a characteristic orange to reddish purple color. Outcrops of the North Horn formation are rare, and usually seen on very steep eroded slopes or in landslide areas. The North Horn formation is about 800 – 1,000 feet thick in the permit area.

The Flagstaff Limestone forms isolated “caps” on the highest peaks of East Mountain. The Flagstaff Limestone is a fresh water lacustrine limestone which is about 100 to 200 feet thick. This limestone is hard and resistant.

In terms of potential subsidence, this combination of hard and soft formations has a beneficial effect. The Castlegate Sandstone is generally considered a barrier to subsidence. It is so thick and massive that in some places such as Trail Mountain, the Castlegate essentially prevents subsidence cracking from reaching the surface. No surface cracks have been detected on Trail

Mountain. The softer formations above the Castlegate have a tendency to move and settle without major cracking due to their softer nature.

Most of the surface cracking in the Deer Creek mine area has occurred in shallow cover areas of Blackhawk Formation exposures, or along the edges of groups of longwall panels.

Because the Castlegate Sandstone is a prominent cliff-former, subsidence damage to the formations overlying the mines is concentrated in the Castlegate. This damage takes place when undermining causes vertical and overhanging cliff faces and balanced rocks to fail. Cliff failures of this type have been isolated to Newberry Canyon and Corncob Wash above the Cottonwood mine, and a section of cliff above the Trail Mountain Mine, and represent a fraction of the total amount of Castlegate Sandstone cliffs undermined. Minor rock falls above the Deer Creek Mine on the south side of Rilda Canyon have also been documented. Energy West is currently involved in an extensive study of the effects of subsidence on the Castlegate sandstone cliffs on the north side of Rilda Canyon. The results of this study will determine the effectiveness of the empirical model developed and used to predict the likelihood of cliff failure.

The Castlegate Sandstone outcrop within the permit area exhibits prominent cliffs and points, especially in the head of Mill Fork Canyon. Some of these will probably be susceptible to subsidence damage. Most of the prominent Castlegate Sandstone cliffs, however, occur above areas where the coal seams are too thin to be considered mineable. Undermining of the Castlegate on the Joes Valley side of the permit area is prevented by the angle-of -draw buffer zone to keep mining away from the Joes Valley Fault.

R645-301-630 OPERATION PLAN

The permit area contains areas of mineable coal in both the Blind Canyon and Hiawatha seams. At present, the operation plan is to drive mains in the Hiawatha seam from the northwest corner of the Deer Creek mine northwest into the Mill Fork ~~permit~~ area then drive mains from south to north, bisecting the lease. Longwall panels in the southern Hiawatha reserves area will be developed as the mains are driven northward.

The Blind Canyon seam is mineable in the north half of the lease. When the Hiawatha seam mains pass under the mineable Blind Canyon reserves, slopes will be driven upward into the Blind Canyon seam. Blind Canyon seam development will take place with mains bisecting the reserve from south to north, and east-west longwall panels on either side of the mains. When the Blind Canyon reserves are extracted, development of the Hiawatha reserves that underly the Blind Canyon mineable area will then be developed and extracted.

R645-301-631 CASING AND SEALING OF BOREHOLES

Each coal exploration permit application will include a description of the methods used to backfill, plug, case, cap, seal or otherwise manage exploration holes or boreholes to prevent acid or toxic drainage from entering water resources, minimize disturbance to the livestock, fish and wildlife, and machinery in the permit and adjacent area. Each exploration hole or borehole that is uncovered or exposed by coal mining and reclamation operations within the permit area will be permanently closed, unless approved for water monitoring or otherwise managed in a manner approved by the Division. Use of an exploration borehole as a water monitoring or water well must meet the provisions of R645-301-731. The requirements of R645-301-731.400 do not apply to boreholes drilled for the purposes of blasting.

Exploration boreholes are plugged after use by filling the hole from total depth to the surface with type II portland cement/abandonite. If circulation cannot be maintained within the borehole, enough cement/abandonite to fill the borehole completely is pumped to the bottom of the hole, then the remainder of the hole is filled with bentonite chips or pellets to within the top 5' of the hole, and a cement surface plug containing a permanent hole identification marker is placed in the top of the hole. This hole plugging method is approved by the B.L.M. and D.O.G.M., and is used on all present and future exploration boreholes.

If an exploration borehole is to be converted to a water monitoring well, the water well regulations of the State of Utah are used to construct the well completion.

R645-301-632 SUBSIDENCE MONITORING

All mining within the permit area will be underneath the uninhabited East Mountain area. No dwellings or building structures will be undermined. A single gas well, own and operated by Merit Energy, is located within the permit area (identified as Federal #23-32), near the center of Section 23, T.16 S., R.6E. The well is near the southern extent of the mine plan. A gas transmission pipeline extends from this well south along forest road #244 for about 2,000 feet, then exits the permit area to the south. No mining is planned under the pipeline. Another gas pipeline segment is buried along forest road #017 in the southwest corner of the permit area. This pipeline will not be undermined. PacifiCorp and Merit Energy entered into an agreement to establish a working relationship regarding multiple mineral development to insure the maximum utilization of the coal and oil and gas estates in certain lands in Emery County, Utah all in the interest of the conservation and full utilization of natural resources.

As stated in the agreement, "Merit is the owner and operator of a producing gas well in the Area of Interest identified as Well No. 32-23. The well was drilled in 1989. PacifiCorp is conducting active coal mining operations in the Area of Interest in the immediate vicinity of Well No. 32-23 by and through Interwest Mining Company, a wholly owned subsidiary, as its managing agent, and Energy West Mining Company, another wholly owned subsidiary, as mine operator. These mining operations are in the Deer Creek Mine in the 12^{th} West longwall panel, off of the 7^{th} North Mains. It is anticipated that the full extraction of PacifiCorp's 12th West longwall panel could potentially cause a subsidence impact on Well No. 32-23. The parties wish to enter into a proactive agreement to establish the working relationship among the parties as this multiple mineral development activity takes place so as to insure the safe and effective compatible usage of both the coal and the oil and gas estates and to achieve maximum economic recovery of these natural resources". The multiple mineral development agreement was signed by all parties (PacifiCorp, Merit Energy, Division of Oil, Gas & Mining and SITLA) and became effective on August 12, 2005. This agreement achieves the purpose and intents of Utah Administrative Code R649-3-27.2 such that a cooperative agreement exists between Merit and PacifiCorp which allows multiple mineral development.

Energy West will report of the subsidence monitoring related to Well No. 32-23 in the Annual Subsidence Reports.

Two power transmission lines are present within the permit area. The largest is the Utah Power 345 KV line that crosses the southwest corner of the permit area in Section 22, T.16S., R.6 E.. The "Plan of Operations" approved in November 2002 included mining adjacent to the powerline over the western end of the 11^{th} West - 12^{th} West Hiawatha longwall panel. Development mining in 11^{th} and 12^{th} West intercepted an extensive split in the Hiawatha seam which limited western development. Based on an revised mine plan, mining will not affect the 345 KV line. ~~About 700 feet of this line, including two towers, cross over the western end of the 2nd Left - 3rd Left Hiawatha longwall panel.~~ This transmission line is owned and operated by Utah Power, a subsidiary of PacifiCorp. A second transmission line (25 KV) carries electricity from the lower portion of Mill Fork Canyon over the top of Mill Fork Ridge, and down into Crandall Canyon, to the Genwal Mine. This line crosses the small portion of the permit area that projects eastward (NW ¼ NW ¼ Section 8, T.16S. R.7 E.). This transmission line will not be undermined. Genwal Coal Company maintains a radio repeater at the Mill Fork summit in Section 7, T.16S. R.7 E.. This repeater will not be undermined.

The only roads that will be undermined are the unimproved dirt trails that provide access to the top of the ridge. Subsidence damage to these roads is expected to be minimal, based on previous experience at the existing mines mentioned above.

The method used to detect and document subsidence on East Mountain divides the land surface into separate study areas based on the second-mining areas in the mine plan. These areas are then studied using photogrammetric comparisons of each successive year of mining progress. The photogrammetry is tied to known survey baseline points that are flagged each year.

R645-301-641 SEALING OF BOREHOLES

All exploration boreholes are sealed upon completion using the following method. The borehole is sealed with cemented/abandonite from bottom to top through the drill pipe or other pipe lowered into the hole. As much cement/abandonite is used to fill the hole, or if the hole does not fill, enough cement/abandonite to fill the hole plus 10% is pumped through the pipe into the hole. If the hole does not fill to the surface, the remainder of the hole is filled with bentonite chips to within 5' of the surface. A cement surface plug is placed in the hole, and a brass marker with the hole number and year is placed on top of the cement, two feet below surface grade.